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Autonomous Aerial Sensors for Wind Power Meteorology

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This poster describes a new approach for measurements in wind power meteorology using small unmanned flying platforms. During a week of flying a lighter-than-air vehicle, two small electrically powered aeroplanes and a larger helicopter at the Risø test station at Høvsøre, we will compare wind speed measurements with fixed mast and LIDAR measurements, investigate optimal flight patterns for each measurement task, and measure other interesting meteorological features like the air-sea boundary in the vicinity of the wind farm. In order to prepare the measurement campaign, a workshop is held, soliciting input from various communities.

Large-scale wind farms, especially offshore, need an optimisation between installed wind power density and the losses in the wind farm due to wake effects between the turbines. While the wake structure behind single wind turbines onshore is fairly well understood, there are different problems offshore, thought to be due mainly to the low turbulence. Good measurements of the wake and wake structure are not easy to come by, as the use of a met mast is static and expensive, while the use of remote sensing instruments either needs significant access to the turbine to mount an instrument, or is complicated to use on a ship due to the ship's own movement. In any case, a good LIDAR or SODAR will cost many tens of thousands of euros.
Another current problem in wind energy is the coming generation of wind turbines in the 10-12 MW class, with tip heights of over 200 m. Very few measurement masts exist to verify our knowledge of atmospheric physics – all that is known is that the boundary layer description we used so far is not valid any more.
Here, automated Unmanned Aerial Vehicles (UAVs) could be used as either an extension of current high masts or to build a network of very high 'masts' in a region of complex terrain or coastal flow conditions. In comparison to a multitude of high masts, UAVs could be quite cost-effective.
In order to test this assumption and to test the limits of UAVs for wind power meteorology, this project assembles four different UAVs from four participating groups. Risø will build a lighter-than-air kite with a long tether, Bergen University flies a derivative of the Funjet, a pusher airplane below 1 kg total weight, Mavionics or TU Braunschweig flies the Carolo, a 2m wide two prop model with a pitot tube on the nose, and Aalborg University will use a helicopter for their part. All those platforms will be flown during one week at the Danish national test station for large wind turbines at Høvsøre. The site is strongly instrumented, with 6 masts reaching up to 167m. The comparison of wind speed measurements from planes and fixed masts should give an indication of the accuracy of the measured wind field.
A workshop is planned as preparation, where everyone with an interest in the program can give input.